

A NOTE ON THE LAND AND SEA BREEZES OF SOUTH AFRICA.

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There is possibly room for some doubt whether the winds Mr. A. G. Howard has discussed in his paper, "An Investigation into the Land and Sea Breezes Conditions at Port Elizabeth,"* are, strictly speaking, land and sea breezes at all. A counter-clockwise rotation of the wind round the sub-solar point is common enough in our latitudes both at coast places and inland, as well as on islands. Thus, *e.g.*, at Kimberley there are prevailing winds approximately N.E. about sunrise, N.W. about noon, S.W. at sunset, and S.E. at midnight. An analysis of the winds of East London which I made some years ago showed a similar counter-clockwise rotation; but with northerly winds at midnight, and southerly winds at noon.† The difference in time-epoch for any direction between Kimberley and East London is no doubt attributable to a real land-and-sea-breeze effect. But the deduced mechanical resultant directions indicate that the sea breeze—such as it is—is at its height during the early hours of the afternoon, while the land breeze is in evidence from before midnight to sunrise. So far from either breeze existing at VIII. and XX., these are just the times when they have both practically died away.

Mr. Howard would have been upon more certain ground if he had got the loan of the continuous records of the anemometer belonging to Port

* *Trans. R. S. S. Af.*, vol. ii., pt. 2, 1911.

† "The Winds of East London," *Q. J. R. Met. S.*, April, 1905. See also the Presidential Address to Section A of the S. A. A. S., 1906.

Elizabeth Harbour Board, and worked up the directions for each hour. Probably if he had done so he would have found the same rule as prevails at various other coast places, *i.e.*, that the winds belong to three superimposed systems: (1) a more or less strong counter-clockwise diurnal rotation depending to some extent upon the season of the year; (2) prevailing winds (depending upon the pressure gradient) up or down the coast; and (3) a slight land-and-sea-breeze effect which at once perturbs the diurnal rotation and causes a deviation land- or sea-wards of the prevailing gradient winds. No study of South African winds promises to be quite complete unless it comprises at least four equidistant observations a day. When the observations are only made at two equidistant hours (*e.g.*, VIII. and XX.) they can only be of use as extending the continuous observations made at some adjacent observatory.

In this connection the winds of Delagoa Bay are of interest. The information given below is partly summarised and partly computed from the important second annual report of the Observatorio Campos Rodrigues.

The average velocities for the year 1910 are :—

TABLE 1.
MEAN HOURLY VELOCITIES OF THE WIND FOR EACH MONTH AT
LOURENÇO MARQUES.

	Kilometers per Hour.	Miles per Hour.
January	20·94	13·0
February	21·05	13·2
March.....	22·03	13·8
April	20·67	13·1
May	21·01	13·0
June	21·92	13·6
July	20·91	13·0
August	23·94	14·9
September	26·83	16·6
October	25·91	16·1
November	27·19	16·9
December	25·94	16·1
Year	23·19	14·4

For the year, therefore, this gives a mean velocity only 72 per cent. of that of the wind of East London.

TABLE 2.

MEAN HOURLY VELOCITIES OF THE WIND FOR EACH HOUR AT
LOURENÇO MARQUES.

Hour.	Kilometers.	Miles.
I.....	19·8	12·2
II.	19·7	12·2
III.	20·2	12·6
IV.	20·8	13·0
V.	20·5	12·7
VI.	20·4	12·7
VII.	21·0	13·1
VIII.	21·2	13·2
IX.	22·2	13·8
X.	22·5	14·0
XI.	21·9	13·6
Noon	22·5	14·0
XIII.	23·8	14·8
XIV.	24·4	15·2
XV.....	26·8	16·6
XVI.	27·7	17·2
XVII.	28·4	17·6
XVIII.	28·1	17·4
XIX.	27·4	17·0
XX.	25·9	16·1
XXI. ...	25·0	15·6
XXII.....	22·9	14·2
XXIII.	21·3	13·2
Midnight	20·3	12·6

This differs considerably from the diurnal curves of velocity for Kimberley and East London in that while these two last show the greatest velocity for the day between XIII. and XIV. o'clock, at Lourenço Marques the maximum velocity comes in the late afternoon. A curious feature—not altogether unknown elsewhere, however—in the diurnal curve for the latter place is the fall in velocity in most of the months at 11 a.m.

Table 3 shows the prevailing winds during each quarter of the year. It shows the number of hours in each quarter in which the vane was pointing in any given direction.

TABLE 3.

WIND FREQUENCY IN HOURS FOR EACH QUARTER OF THE YEAR.

	Jan. to March.	April to June.	July to Sept.	Oct. to Dec.	Year.
N.	35	141	212	95	483
N.N.E.	47	104	114	97	362
N.E. ...	42	89	185	269	555
E.N.E.	278	190	199	228	895
E.	233	93	110	165	601
E.S.E.	258	117	90	187	652
S.E. ...	106	54	63	128	351
S.S.E....	242	124	105	183	654
S.	41	45	107	244	437
S.S.W.	414	266	198	229	1,107
S.W. ...	201	270	228	53	752
W.S.W.	67	122	80	18	287
W.	9	43	41	37	130
W.N.W.	71	102	87	61	321
N.W. ...	44	84	138	82	348
N.N.W.	72	340	251	128	791

The numbers of Table 3 give the following North and East Components of direction, Kimberley values for 1910 being added for comparison :—

TABLE 4.

WIND DIRECTION COMPONENTS.

	Lourenço Marques.		Kimberley.	
	N.	E.	N.	E.
1910.				
January to March	- 643	+ 448	+ 321	+ 394
April to June	+ 59	- 167	+ 209	+ 416
July to September	+ 234	+ 10	- 44	+ 429
October to December	- 169	+ 594	- 27	+ 191
Year	+ 519	+ 885	+ 459	+ 1,430

Table 4 shows that wind directions in Delagoa Bay prevail in the south-east quadrant (*i.e.*, from the sea) from October to March, being rather to the north of east-south-east from October to December, and slightly to the north of south-south-east from January to March; whereas in the winter half of the year there is a small preponderance of direction from the land, say, from a west-north-west direction during April-June, and from nearly due north from July to September. (See Fig. 1.)

Considering the total duration for the year of each wind direction we find that the commonest winds are south-south-west, east-north-east, and north-north-west, in order of frequency. That is to say, the prevailing

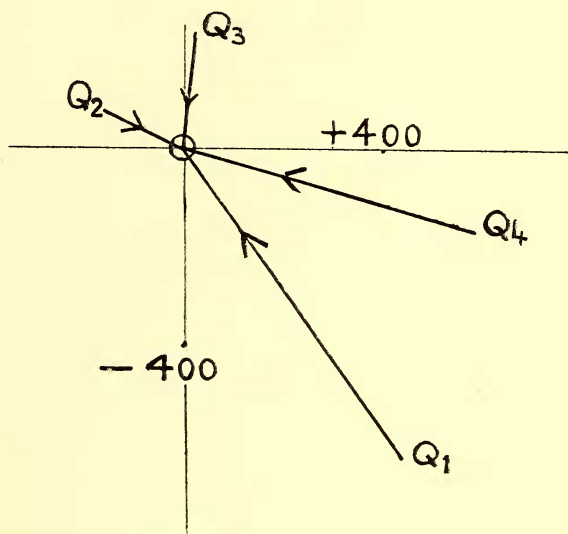


FIG. 1.

winds blow up or down the coast as they do at East London. The winds of secondary importance, namely, those from the north-north-west, are mainly a winter phenomenon. They occur also at East London at the same season, albeit the duration there is relatively less important than it is in Delagoa Bay. At both places they may fairly be regarded as arising from similar barometric conditions, and as blowing from the cooled interior to the warmer area dominated by the Mozambique Current. Besides being winter winds they are also essentially night and morning winds, for they appear but rarely in the afternoons. It is these winds that are usually responsible for the hot (foehn) winds of the coast belt during the late winter and early spring months.

So far as one year's observations can be trusted, then, the results of the wind observations at Lourenço Marques show—as the longer period at East London showed—that the current statements, and the physical atlases, are wrong in the prevailing directions they assign to the winds of the south and south-east coast of South Africa. The “prevailing south-east rain-bearing wind” is, in fact, a myth; and as Captain Campbell Hepworth has pointed out (though little notice seems to have been taken of his testimony), south-east winds may blow fifty or a hundred miles to seaward, yet they are deflected as they approach the coast, so as to take the direction of the coast-line.*

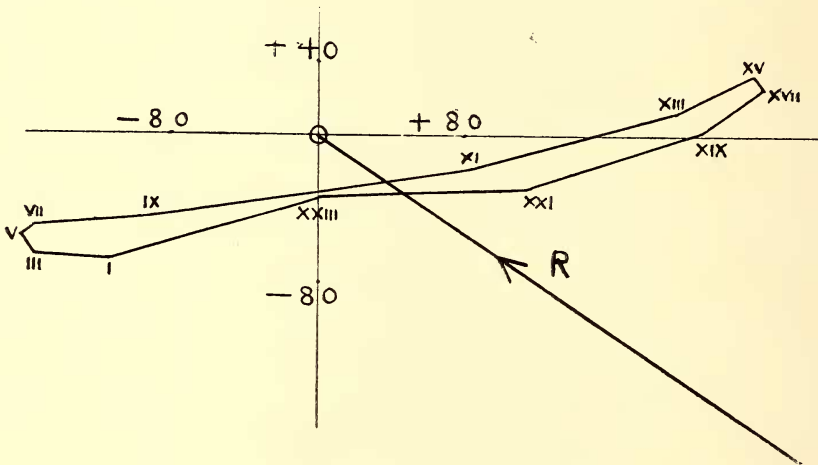


FIG. 2.

Of more immediate consequence to the main subject-matter of this paper, however, is the diurnal oscillation of the vane at Lourenço Marques. In the Report from which the greater part of the above information has been extracted the directions and velocities have been given for every alternate hour of each day, *i.e.*, at I., III., V., VII., &c. I have tabulated the directions for each given hour and worked out their Cartesian components. The component velocities have not been dealt with here, the business being simply with the directions at particular hours. Results are given in Table 5.

* M. W. Campbell Hepworth, “Weather Forecasts and Storm Warnings on the Coast of South Africa.” Read before the Meteorological Society in February, 1883. Reprinted in “Notes on Maritime Meteorology,” 1907.

TABLE 5.

DIURNAL VARIATION OF WIND FREQUENCY IN HOURS.

	I.	III.	V.	VII.	IX.	XI.	XIII.	XV.	XVII.	XIX.	XXI.	XXIII.
N.	23	22	25	28	18	22	19	15	15	14	15	29
N.N.E.	14	6	4	7	2	5	5	3	19	36	47	33
N.E.	4	7	4	—	2	9	27	52	66	51	49	25
E.N.E.	10	4	4	4	8	20	66	103	88	72	39	23
E.	9	3	3	4	8	43	71	50	37	29	22	18
E.S.E.	5	3	3	4	10	53	54	49	48	44	26	9
S.E.	5	3	2	3	17	31	26	22	33	24	20	8
S.S.E.	20	11	7	11	23	33	23	26	31	54	56	28
S.	25	24	24	18	36	12	8	5	8	14	26	30
S.S.W.	74	79	80	80	57	31	12	14	8	13	36	59
S.W.	55	66	64	62	45	17	9	4	4	4	12	41
W.S.W. ...	23	27	32	31	15	6	3	1	2	3	1	8
W.	18	14	11	8	6	1	1	—	—	1	2	4
W.N.W. ...	20	29	30	31	14	8	2	1	1	—	6	16
N.W.	21	23	24	22	39	16	8	3	3	3	4	11
N.N.W. ...	39	44	48	51	65	58	31	17	2	3	4	23

These numbers give the Cartesian components of Table 6, which are also shown graphically in Fig. 2.

TABLE 6.

WIND DIRECTION COMPONENTS.

Hour.	N.	E.
I.	—64	—112
III.	—65	—153
V.	—59	—162
VII.	—51	—154
IX.	—46	— 91
XI.	—19	+ 82
XIII.	+16	+196
XV.	+33	+235
XVII.	+28	+240
XIX.	+ 2	+209
XXI.	—27	+135
XXIII.	—30	— 0
Day	—233	+425

The mean resultant direction for the day is from somewhere to the north of south-east, due, no doubt, to the influence of the trade winds; * while the hourly resultants show land- and sea-breeze movements approximately parallel to the north arm of the oblique angle of coast forming Delagoa Bay. The sea-breeze effect as depicted in Fig. 2 is at its height from XV. to XVII. o'clock, while the land breeze reaches its maximum just before sunrise. The counter-clockwise rotation of the vane is not apparent at Lourenço Marques.

* The mean resultant direction at East London is almost exactly from the opposite direction.

EXPLANATION OF THE FIGURES.

In Fig. 1, the vectors Q_1O , Q_2O , Q_3O , Q_4O represent the resultant directions in magnitude and direction for each quarter of the year.

In Fig. 2, the resultant direction for any hour is supposed to blow from the place of that hour on the diagram to the origin O . Thus, *e.g.*, at XIX. o'clock the resultant direction is from almost due east. The vector RO represents the total resultant direction for the year in direction, but on a reduced scale.